Rock Identification Tables

These tables will help you identify almost any rock you're likely to find. Read How to Look at a Rock for help with your observations.

First, decide whether your rock is igneous, sedimentary or metamorphic.

- **Igneous:** A tough, frozen melt with little texture or layering; mostly black, white and/or gray minerals; may look like lava (igneous rocks)
- **Sedimentary:** Hardened sediment with layers (strata) of sandy or clayey stone; mostly brown to gray; may have fossils and water or wind marks (sedimentary rocks)
- **Metamorphic:** Tough rock with layers (foliation) of light and dark minerals, often curved; various colors; often glittery from mica (metamorphic rocks)

Next, check the rock's grain size and hardness. Then start in the left column of the appropriate table below and work your way across. Follow the links to pictures and more information. If you don't find a match, try another of the three big types.

Grain Size: "Coarse" grains are visible to the naked eye (greater than about 0.1 millimeter), and the minerals can usually be identified using a magnifier; "fine" grains are smaller and usually cannot be identified with a magnifier.

Hardness: Hardness (as measured with the Mohs scale) actually refers to minerals rather than rocks, so a rock may be crumbly yet consist of hard minerals. But in simple terms, "hard" rock scratches glass and steel, usually signifying the minerals quartz or feldspar (Mohs hardness 6-7 and up); "soft" rock does not scratch a steel knife but scratches fingernails (Mohs 3-5.5); "very soft" rock does not scratch fingernails (Mohs 1-2). Igneous rocks are always hard.

Resource:

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Identification of Igneous Rocks

Grain Size	Usual Color	Other	Composition	Rock Type
fine	dark	glassy appearance	lava glass	Obsidian
fine	light	many small bubbles	lava froth from sticky lava	Pumice
fine	dark	many large bubbles	lava froth from fluid lava	Scoria
fine or mixed	light	contains quartz	high-silica lava	Felsite
fine or mixed	medium	between felsite and basalt	medium-silica lava	Andesite
fine or mixed	dark	has no quartz	low-silica lava	Basalt
mixed	any color	large grains in fine-grained matrix	large grains of feldspar, quartz, pyroxene or olivine	Porphyry
coarse	light	wide range of color and grain size	feldspar and quartz with minor mica, amphibole or pyroxene	Granite
coarse	light	like granite but without quartz	feldspar with minor mica, amphibole or pyroxene	Syenite
coarse	medium to dark	little or no quartz	low-calcium plagioclase and dark minerals	Diorite
coarse	medium to dark	no quartz; may have olivine	high-calcium plagioclase and dark minerals	Gabbro
coarse	dark	dense; always has olivine	olivine with amphibole and/or pyroxene	Peridotite
coarse	dark	dense	mostly pyroxene with olivine and amphibole	Pyroxenite
coarse	green	dense	at least 90% olivine	Dunite
very coarse	any color	usually in small intrusive bodies	typically granitic	Pegmatite

Obsidian is an extrusive rock: lava that cooled without forming crystals, giving it a glassy texture.

Obsidian is an extreme variety of igneous rock with a glassy texture. Most popular accounts say that obsidian forms when lava cools very quickly, but that is not quite accurate. Obsidian starts with a lava very high in silica (more than about 70 percent), such as a rhyolite.

The many strong chemical bonds between silicon and oxygen make such a lava very viscous, but equally important is that the temperature range between fully liquid (the liquidus) and fully solid (the solidus) is very small. Thus obsidian does not need to cool especially fast, because it solidifies especially fast.

Pumice is basically lava froth, an extrusive rock frozen as its dissolved gases come out of solution. It looks solid but often floats on water.
This pumice specimen is from the Oakland Hills in northern California and reflects the high-silica (felsic) magmas that form when subducted marine crust mixes with granitic continental crust. Pumice may look solid, but it's full of small pores and spaces and weighs very little. Pumice is easily crushed and used for abrasive grit or soil amendments.

Pumice is much like scoria in that both are frothy, lightweight volcanic rocks, but the bubbles in pumice are small and regular and its composition is more felsic than scoria's. Also, pumice is generally glassy whereas scoria is a more typical lava with microscopic crystals.

Scoria, like pumice, is a lightweight extrusive rock, but scoria has large, distinct gas bubbles and a darker color.

Another name for scoria is volcanic cinders, and the landscaping product commonly called "lava rock" is scoria, as is the cinder mix widely used on running tracks.

Scoria is more often a product of basaltic, low-silica lavas than of felsic, high-silica lavas. This is because basalt is usually more fluid than felsite, allowing bubbles to grow larger before the rock freezes. Scoria often forms as a frothy crust on lava flows that crumbles off as the flow moves. It also is blown out of the crater during eruptions. Unlike pumice, scoria usually has broken, connected bubbles and does not float in water.

Felsite is a general name for light-colored extrusive igneous rocks. Ignore the dark dendritic growths on this specimen's surface.

Felsite is fine grained but not glassy, and it may or may not have phenocrysts (large mineral grains). It is high in silica or *felsic*, typically consisting of the minerals quartz, plagioclase feldspar and alkali feldspar. Felsite is usually called the extrusive equivalent of granite.

A common felsitic rock is rhyolite, which typically has phenocrysts and signs of having flowed. Felsite should not be confused with tuff, a rock made up of compacted volcanic ash that can also be light colored.

Basalt is an extrusive or intrusive rock that makes up most of the world's oceanic crust.

Basalt is fine-grained so that the individual minerals are not visible, but they include pyroxene, plagioclase feldspar and olivine. These minerals are visible in the coarse-grained, plutonic version of basalt called gabbro.

This specimen shows bubbles made by carbon dioxide and water vapor that came out of the molten rock as it approached the surface. During its long period of storage beneath the volcano, green grains of olivine came out of solution as well. So the bubbles, or vesicles, and the grains, or phenocrysts, represent two different events in the history of this basalt.

Porphyry ("PORE-fer-ee") is a name used for any igneous rock with conspicuous larger grains—phenocrysts—floating in a fine-grained groundmass.

Geologists use the term porphyry only with a word in front of it describing the composition of the groundmass. This image, for instance, shows an andesite porphyry. The fine-grained part is andesite and the phenocrysts are light alkali feldspar and dark biotite. Geologists also may call this an andesite with porphyritic texture. That is, "porphyry" refers to a texture, not a composition, just as "satin" refers to a type of fabric rather than the fiber it's made from (see the various igneous rock textures). A porphyry may be plutonic, intrusive or extrusive.

Granite consists of quartz (gray), plagioclase feldspar (white) and alkali feldspar (beige) plus dark minerals like biotite and hornblende.

Syenite is a plutonic rock consisting chiefly of potassium feldspar with a subordinate amount of plagioclase feldspar and little or no quartz.

The dark, mafic minerals in syenite tend to be amphibole minerals like hornblende.

Being a plutonic rock, syenite has large crystals from its slow underground cooling. An extrusive rock of the same composition as syenite is called trachyte. Syenite is named for the city of Syene, Egypt, where many ancient monuments are made of a light-colored stone like this.

Diorite is a plutonic rock that is something between granite and a gabbro. It consists mostly of white plagioclase feldspar and black hornblende.
Unlike granite, diorite has no or very little quartz or alkali feldspar; unlike gabbro it is fairly light colored—half black and half white—and under the microscope it has sodic, not calcic plagioclase. If a dioritic rock is erupted from a volcano (that is, if it is extrusive), it cools into andesite lava.

The official definition of diorite is narrower than what the average geologist calls diorite. With more quartz, diorite becomes tonalite. With more alkali feldspar, diorite becomes monzonite. With more of both minerals, diorite becomes granodiorite.

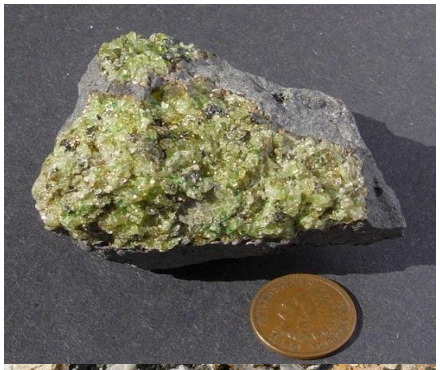
Gabbro is a dark plutonic rock that is considered to be the plutonic equivalent of basalt.

Unlike granite, gabbro is low in silica and has no quartz; also gabbro has no alkali feldspar, only plagioclase that often is dark with a high calcium content. The other dark minerals may include amphibole, pyroxene and sometimes biotite, olivine, magnetite, ilmenite and apatite. This particular gabbro is mostly hornblende, magnetite and light-colored plagioclase.

Gabbro is named after a town in Tuscany, Italy. You can get away with calling almost any dark, coarse-grained igneous rock gabbro.

Peridotite is the plutonic rock beneath the Earth's crust, in the upper part of the mantle. It is named for peridot, the gemstone name of olivine.
Peridotite (per-RID-a-tite) is very low in silicon and high in iron and magnesium, a combination called ultramafic. It doesn't have enough silicon to make the minerals feldspar or quartz, only mafic minerals like olivine and pyroxene. These dark and heavy minerals make peridotite much denser than most rocks. Where lithospheric plates pull apart, along the midocean ridges, the release of pressure on the peridotite mantle allows it to partially melt. That melted portion, richer in silicon and aluminum, rises to the surface as basalt.
This peridotite boulder is partially altered to serpentine minerals, but it has visible grains of pyroxene sparkling in it as well as serpentine veins. Most peridotite is metamorphosed into serpentinite during the processes of plate tectonics, but sometimes it survives to appear in subduction-zone rocks like the rocks of Shell Beach, California.

Pyroxenite is a plutonic rock that consists of dark minerals in the pyroxene group plus a little olivine or amphibole minerals.
Pyroxenite belongs to the ultramafic group, meaning that it consists almost entirely of dark minerals rich in iron and magnesium. Specifically, its silicate minerals are mostly pyroxenes rather than the other mafic minerals, olivine and amphibole. In the field, pyroxene crystals display a stubby shape and square cross-section whereas amphiboles have a lozenge-shaped cross-section. Pyroxenite is often associated with its ultramafic cousin peridotite. Rocks like these originate deep in the seafloor, underneath the basalt that makes up the upper oceanic crust. They occur on land where slabs of oceanic crust become attached to continents, that is, at subduction zones.



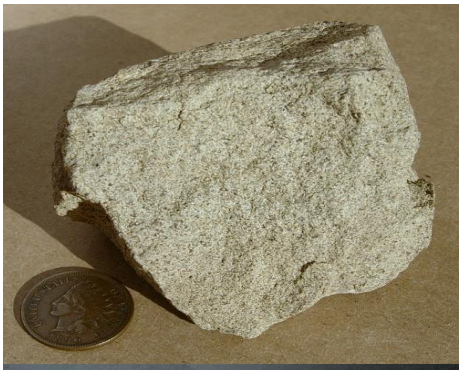
Dunite is a rare rock, a peridotite that is at least 90 percent olivine. It's named for Dun Mountain in New Zealand.

Pegmatite is a plutonic rock with exceptionally large crystals. It forms at a late stage in the solidification of granite bodies.
Pegmatite is a rock type based purely on grain size. Generally pegmatite is defined as a rock bearing abundant interlocking crystals 3 centimeters and larger. However, most pegmatite bodies consist largely of quartz and feldspar and are associated with granitic rocks.

Pegmatite bodies are thought to form predominantly in granites during their final stage of solidification. The final fraction of mineral material is high in water and often also in elements such as fluorine or lithium. This fluid is forced to the edge of the granite pluton and forms thick veins or pods. The fluid apparently solidifies rapidly at relatively high temperatures, under conditions that favor a few very large crystals rather than many small ones. The largest crystal ever found was in a pegmatite, a spodumene grain some 14 meters long. Pegmatites are sought out by mineral collectors and gemstone miners not only for their large crystals, but for their examples of rare minerals.

Identification of Sedimentary Rocks

Hardness	Grain Size	Composition	Other	Rock Type
hard	coarse	clean quartz	white to brown	Sandstone
hard	coarse	quartz and feldspar	usually very coarse	Arkose
hard or soft	mixed	mixed sediment with rock grains and clay	gray or dark and "dirty"	Wacke/ Graywacke
hard or soft	mixed	mixed rocks and sediment	round rocks in finer sediment matrix	Conglomerate
hard or soft	mixed	mixed rocks and sediment	sharp pieces in finer sediment matrix	Breccia
hard	fine	very fine sand; no clay	feels gritty on teeth	Siltstone
hard	fine	chalcedony	no fizzing with acid	Chert
soft	fine	clay minerals	foliated	Shale
soft	fine	carbon	black; burns with tarry smoke	Coal
soft	fine	calcite	fizzes with acid	Limestone
soft	coarse or fine	dolomite	no fizzing with acid unless powdered	Dolomite rock
soft	coarse	fossil shells	mostly pieces	Coquina
very soft	coarse	halite	salt taste	Rock Salt
very soft	coarse	gypsum	white, tan or pink	Rock Gypsum



Sandstone forms where sand is laid down and buried—beaches, dunes and seafloors. Usually sandstone is mostly quartz.

Arkose is a raw, coarse-grained sandstone, deposited very near its source that consists of quartz and a significant proportion of feldspar.
Arkose is known to be young because of its content of feldspar, a mineral that usually degrades quickly into clay. Its mineral grains are generally angular rather than smooth and rounded; another sign that they were transported only a short distance from their origin. Arkose usually has a reddish color from feldspar, clay and iron oxides—ingredients that are uncommon in ordinary sandstone.

Arkose is similar to graywacke, which is also a rock laid down near its source. But whereas graywacke forms in a seafloor setting, arkose generally forms on land or near shore specifically from the rapid breakdown of granitic rocks. This arkose specimen is of late Pennsylvanian age (about 300 million years) and comes from the Fountain Formation of central Colorado, the same stone that makes up the spectacular outcrops at Red Rocks Park, south of Golden. The granite that gave rise to it is exposed directly underneath it and is more than a billion years older.

Wacke ("wacky") is a name for poorly sorted sandstone, a mixture of grains of sand, silt and clay size. Graywacke is a specific type of wacke.
Wacke contains quartz, like other sandstones, but it also has more delicate minerals and small fragments of rock (lithics). Its grains are not well rounded. But this hand specimen is in fact a graywacke, which refers to a specific origin as well as a wacke composition and texture. The British spelling is "greywacke." Graywacke forms in the seas near fast-rising mountains. The streams and rivers from these mountains yield fresh, coarse sediment that doesn't fully weather into proper surface minerals. It tumbles from river deltas down slope to the deep seafloor in gentle avalanches and forms bodies of rock called turbidites. This graywacke is from a turbidite sequence in the heart of the Great Valley Sequence in western California, roughly 100 million years old. It contains sharp quartz grains, hornblende and other dark minerals, lithics and small blobs of claystone. Clay minerals hold it together in a strong matrix.

Conglomerate could be thought of as a giant sandstone, containing grains of pebble size (greater than 4 mm) and cobble size (>64 mm).
Conglomerate forms in a very energetic environment, where rocks are eroded and carried downhill so swiftly that they aren't fully broken down into sand. Another name for conglomerate is puddingstone, especially if the large clasts are well rounded and the matrix around them is very fine sand or clay. A conglomerate with jagged, broken clasts is usually called a breccia.

Conglomerate is often much harder and resistant than the sandstones and shales that surround it. Conglomerate is scientifically valuable because the individual stones are samples of the older rocks that were exposed as it was forming—important clues about the ancient environment.

Breccia is a rock made of smaller rocks, like conglomerate. But breccia contains sharp, broken clasts while conglomerate has smooth, round clasts. Breccia ("BRET-cha") is usually listed under sedimentary rocks, but igneous and metamorphic rocks may become shattered, too. It is safest to think of brecciation as a process rather than breccia as a rock type. As a sedimentary rock, breccia is a variety of conglomerate.

There are many different ways to make breccia, and usually geologists add a word to signify the kind of breccia they're talking about. A sedimentary breccia arises from things like talus or landslide debris. A volcanic or igneous breccia forms during eruptive activities. A collapse breccia forms when rocks are partly dissolved, such as limestone or marble. One created by tectonic activity is a fault breccia. And a new member of the family, first described from the Moon, is impact breccia.

Siltstone is made of sediment that is between sand and clay in the Wentworth grade scale; it's finer grained than sandstone but coarser than shale.
Silt is a size term used for material that's smaller than sand (generally 0.1 millimeter) but larger than clay (around 0.004 mm). The silt in this siltstone is unusually pure, containing very little sand or clay. The absence of clay matrix makes siltstone soft and crumbly, even though this specimen is many millions of years old. Siltstone is defined as having twice as much silt as clay.

The field test for siltstone is that you can't see the individual grains, but you can feel them. Many geologists rub their teeth against the stone to detect the fine grit of silt. Siltstone is much less common than sandstone or shale.

Siltstone usually forms offshore, in quieter environments than the places that make sandstone. Yet there are still currents that carry off the finest clay-size particles. This rock is laminated. It's tempting to suppose that the fine lamination represents daily tidal surges. If so, this stone might represent about a year of accumulation.

Chert is a sedimentary rock composed mostly of the mineral chalcedony—cryptocrystalline silica, or quartz in crystals of submicroscopic size.
Chert can form in parts of the deep sea where the tiny shells of siliceous organisms are concentrated, or elsewhere where underground fluids replace sediments with silica. Chert nodules also occur in altered limestones.
This is a piece of a chert nodule that I found in the Mojave Desert. It shows chert's typical clean conchoidal fracture and waxy luster.
Chert may have a high clay content and look at first glance like shale, but its greater hardness gives it away. Also, the waxy luster of chalcedony combines with the earthy appearance of clay to give it the look of broken chocolate.
Chert grades into siliceous shale or siliceous mudstone.
Chert is a more inclusive term than flint or jasper, two other cryptocrystalline silica rocks. Flint is a dark, hard chert like the rock that prehistoric stone tools are made from, and jasper is a bright, reddish chert associated with iron-rich deposits. All of these have a similar waxy luster, and a hardness and density near that of quartz. Silica rocks of greater purity, translucency, and refined appearance tend to be classified as agate.

Shale is a claystone that is fissile, splitting in layers. Shale is usually soft and does not crop out unless harder rock protects it.
Geologists are strict with their rules on sedimentary rocks. Sediment is divided by particle size into gravel, sand, silt and clay. Claystone must have at least twice as much clay as silt and no more than 10 percent sand. It can have more sand, up to 50 percent, but that is called a sandy claystone. What makes a claystone shale is the presence of fissility—it splits in more or less thin layers whereas claystone is massive.
Shale can be fairly hard if it has a silica cement, making it closer to chert, but usually it is soft and easily weathers back into clay. Shale may be hard to find except in roadcuts, unless a harder stone on top of it protects it from erosion.
When shale undergoes greater heat and pressure, it becomes the metamorphic rock slate. With still more metamorphism, it becomes phyllite, then schist.

Coal is fossilized peat, dead plant material that once piled deep on the bottom of ancient swamps.

Limestone is usually made of the tiny calcite skeletons of microscopic organisms that once lived in shallow seas.
Limestone dissolves in rainwater more easily than other rocks. Rainwater picks up a small amount of carbon dioxide during its passage through the air, and that turns it into a very weak acid. Calcite is vulnerable to acid. That explains why underground caverns tend to form in limestone country, and why limestone buildings suffer from acid rainfall. In dry regions, limestone is a resistant rock that forms some impressive mountains.

Under pressure, limestone metamorphoses into marble. Under gentler conditions that are still not completely understood, the calcite in limestone is altered to dolomite, changing it to dolomite rock.

Dolomite rock, also sometimes called dolostone, is usually a former limestone in which the mineral calcite is altered to dolomite.
Dolomite was first described by the French mineralogist Déodat de Dolomieu in 1791 from its occurrence in a range of the southern Alps. The rock was given the name dolomite by de Saussure, and today the mountains themselves are called the Dolomites. What Dolomieu noticed was that dolomite looks like limestone, but unlike limestone it does not bubble when treated with weak acid. The mineral responsible is also called dolomite.

Dolomite is very significant in the petroleum business because it forms underground by the alteration of calcite limestone. This chemical change is marked by a reduction in volume and by recrystallization, which combine to produce open space (porosity) in the rock strata. Porosity creates avenues for oil to travel and reservoirs for oil to collect. Naturally, this alteration of limestone is called dolomitization, and the reverse alteration is called dedolomitization. Both are still somewhat mysterious problems in sedimentary geology.

Coquina ("co-KEEN-a") is a limestone composed chiefly of shell fragments. It's not common, but when you see it you want to have the name handy.

Coquina is the Spanish word for cockleshells or shellfish. Coquina forms near shore, where wave action is vigorous and sorts the sediments well. Most limestones have some fossils in them, and many have beds of shell hash, but coquina is the extreme version. A well-cemented, strong version of coquina is called coquinite. A similar rock, composed chiefly of shelly fossils that lived where they sit, unbroken and unabraded, is called a coquinoid limestone. That kind of rock is called autochthonous (aw-TOCK-thenus), meaning "arising from here." Coquina is made of fragments that arose elsewhere, so it is allochthonous (al-LOCK-thenus).

Rock salt is an evaporite like rock gypsum, composed of the mineral halite, which is the same as table salt.

Rock gypsum is an evaporite rock that forms as shallow sea basins or salt lakes dry up enough for the mineral gypsum to come out of solution.

Identification of Metamorphic Rocks

Foliation	Grain Size	Hardness	Usual Color	Other	Rock Type
foliated	fine	soft	dark	"tink" when struck	Slate
foliated	fine	soft	dark	shiny; crinkly foliation	Phyllite
foliated	coarse	hard	mixed dark and light	wrinkled foliation; often has large crystals	Schist
foliated	coarse	hard	mixed	banded	Gneiss
foliated	coarse	hard	mixed	distorted "melted" layers	Migmatite
foliated	coarse	hard	dark	mostly hornblende	Amphibolite
nonfoliated	fine	soft	greenish	shiny, mottled surface	Serpentinite
nonfoliated	fine or coarse	hard	dark	dull and opaque colors, found near intrusions	Hornfels
nonfoliated	coarse	hard	red and green	dense; garnet and pyroxene	Eclogite
nonfoliated	coarse	soft	light	calcite or dolomite by the acid test	Marble
nonfoliated	coarse	hard	light	quartz (no fizzing with acid)	Quartzite

Slate is the lowest grade of metamorphic rock, with a dull luster and strong cleavage. It is derived from shale by regional metamorphism.
Slate forms when shale, which consists of clay minerals, is put under pressure with temperatures of a few hundred degrees or so. Then the clays begin to revert to the mica minerals from which they formed. This does two things: first, the rock grows hard enough to ring or "tink" under the hammer, and second, the rock gets a pronounced cleavage direction, so that it breaks along flat planes. *Slaty cleavage* is not always in the same direction as the original sedimentary bedding planes, thus any fossils originally in the rock are usually erased, but sometimes they survive in smeared or stretched form.
With further metamorphism, slate turns to phyllite, then schist or gneiss.
Slate is usually dark, but it can be colorful too. High-quality slate is an excellent paving stone as well as the material of long-lasting slate roof tiles and, of course, the best billiard tables. Blackboards and handheld writing tablets were once made of slate, and the name of the rock has become the name of the tablets themselves.

Phyllite is one step beyond slate in the chain of regional metamorphism. Unlike slate, phyllite has a definite sheen.
Phyllite is from scientific Latin and means "leaf-stone." Phyllite is a medium-gray or greenish stone, but here sunlight reflects off its finely wavy face.

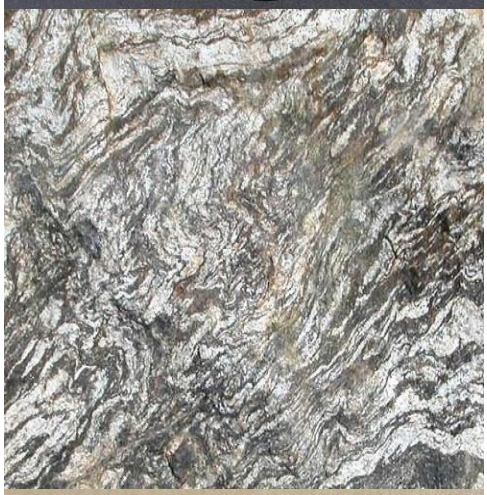
Whereas slate has a dull surface because its metamorphic minerals are extremely fine grained, phyllite has a sheen from tiny grains of mica, graphite, chlorite and similar minerals, because with further heat and pressure, the reflective grains grow more abundant and join each other. And whereas slate usually breaks in very flat sheets, phyllite tends to have a corrugated cleavage.

This rock has nearly all of its original sedimentary structure erased, although some of its clay minerals persist. Further metamorphism will convert all of the clays into large grains of mica, along with quartz and feldspar. At that point, phyllite becomes schist.

Schist is formed by regional metamorphism and has schistose fabric—it has coarse mineral grains and is *fissile*, splitting in thin layers.
Schist is a metamorphic rock that comes in almost infinite variety, but its main characteristic is hinted at in its name: *schist* comes from the ancient Greek for "split," through Latin and French. Schist is a rock formed by dynamic metamorphism at high temperatures and high pressures that aligns the grains of mica, hornblende and other flat or elongated minerals into thin layers, or foliation. At least 50 percent of the mineral grains in schist are aligned this way (less than 50 percent makes it gneiss). The rock may or may not be actually deformed in the direction of the foliation, although a strong foliation probably is a sign of high strain.

Schists are commonly described in terms of their predominant minerals. This specimen, for example, would be called a mica schist because the flat, shiny grains of mica are so abundant. Other possibilities include blueschist (glaucophane schist) or amphibole schist.

Gneiss ("nice") is a rock of great variety with large mineral grains arranged in wide bands. It means a type of rock texture, not a composition.
Gneiss is a typical rock type formed by regional metamorphism, in which a sedimentary or igneous rock has been deeply buried and subjected to high temperatures and pressures. Nearly all traces of the original structures (including fossils) and fabric (such as layering and ripple marks) are wiped out as the minerals migrate and recrystallize. The streaks are composed of minerals, like hornblende, that do not occur in sedimentary rocks.
In gneiss, less than 50 percent of the minerals are aligned in thin, foliated layers. You can see that unlike schist, which is more strongly aligned, gneiss doesn't fracture along the planes of the mineral streaks. And thicker veins of large-grained minerals form in it, unlike the more evenly layered appearance of schist. With still more metamorphism, gneisses can turn to migmatite and then totally recrystallize into granite.
Despite its highly altered nature, gneiss can preserve geochemical evidence of its history, especially in minerals like zircon which resist metamorphism. The oldest crustal rocks known are gneisses from western Greenland. Their carbon isotopes show that life existed there at that time, nearly four billion years ago. Gneiss makes up the largest part of the Earth's lower crust. Pretty much everywhere on the continents, you will drill straight down and eventually strike gneiss. *Gneiss* is an old German word meaning bright or sparkling.

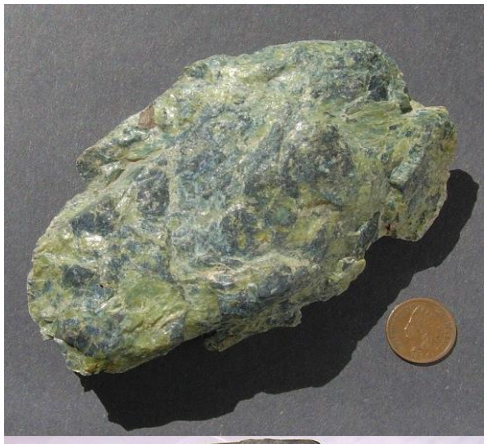


Migmatite is the same material as gneiss, but brought near melting by regional metamorphism so that the veins and layers of minerals became warped.
Migmatite has been buried very deep and squeezed very hard. In many cases the darker part of the rock, consisting of biotite mica and hornblende, has been intruded by veins of lighter rock consisting of quartz and feldspar. With its curling light and dark veins, migmatite can be very picturesque. Yet even with this extreme degree of metamorphism, the minerals are arranged in layers and the rock is clearly classified as metamorphic.

If mixing is even stronger than this, a migmatite can be hard to distinguish from the igneous rock granite. Because it isn't clear that true melting is involved, even at this degree of metamorphism, geologists use the word *anatexis* (loss of texture) instead.

Amphibolite is a rock composed mostly of amphibole minerals. Usually it's a hornblende schist like this as hornblende is the commonest amphibole.

Amphibolite forms when basaltic rock is subjected to higher temperatures (550–750°C) and slightly greater pressure range than that which yields greenschist. Amphibolite is also the name of a *metamorphic facies*—a set of minerals that typically forms at a specific range of temperature and pressure.



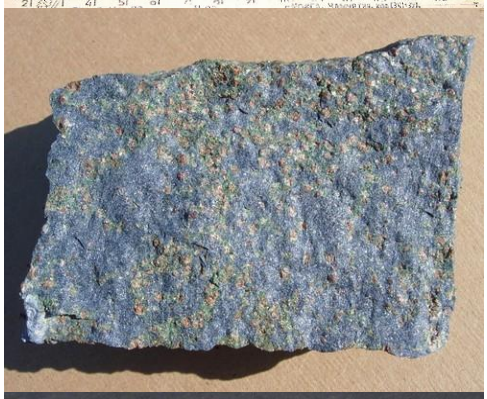
Serpentinite is composed of minerals of the serpentine group. It forms by regional metamorphism of deep-sea rocks from the oceanic mantle. Serpentinite is common beneath the oceanic crust, where it forms by the alteration of the mantle rock peridotite. But it is seldom seen on land except in rocks from subduction zones, where oceanic rocks may be preserved.

Most people call it serpentine (SER-penteen) or serpentine rock, but serpentine is the set of minerals that make up serpentinite (ser-PENT-inite). It gets its name from its resemblance to snakeskin, with a mottled color, waxy or resinous luster and curving, polished surfaces. Serpentinite is a sexy rock.

Serpentinite is low in plant nutrients and high in toxic metals. Thus the vegetation on the so-called serpentine landscape is dramatically different from other plant communities, and serpentine barrens contain many specialized, endemic species.

Serpentinite can contain chrysotile, the serpentine mineral that crystallizes in long, thin fibers. This is the mineral commonly known as asbestos.

Hornfels is a tough, fine-grained rock that is made by contact metamorphism where magma bakes surrounding rocks. Note how it breaks across the original bedding.



Eclogite ("ECK-lo-jite") is an extreme metamorphic rock, formed by regional metamorphosis of basalt under very high pressures and temperatures.
When basaltic rocks are brought to depths of more than 40 kilometers and temperatures above 500°C, the mineral assemblage of olivine and feldspar changes to garnet and pyroxene. It is rare for rocks at that depth to be brought back to the surface, and rarer still for those rocks to avoid being altered again (by retrograde metamorphism) on the way up.

While eclogite is rare at the Earth's surface, it is very common at depth and has an important role in plate tectonics. When oceanic plates are subducted, their great thicknesses of basalt and gabbro change to eclogite and gain nearly 10 percent in density. This change in density makes subducted plates even more eager to descend.

Marble is made by regional metamorphism of limestone or dolomite rock, causing their microscopic grains to combine into larger crystals.
Marble consists of recrystallized calcite (from limestone) or dolomite (from dolomite rock). In this hand specimen of Vermont marble, the crystals are small. For fine marble of the sort used in buildings and sculpture, the crystals are even smaller. The color of marble can range from the purest white to black, ranging through the warmer colors in between depending on the other mineral impurities.

Like other metamorphic rocks, marble has no fossils, and any layering that appears in it probably does not correspond to the original bedding of the precursor limestone. And like limestone, marble tends to dissolve in acidic fluids. It is quite durable in dry climates, as in the Mediterranean countries where ancient marble structures survive.

Quartzite is a tough stone composed mostly of quartz. It may be derived from sandstone or chert by regional metamorphism.
Quartzite forms in two different ways. In the first way, under the high pressures and temperatures of deep burial, sandstone or chert recrystallizes resulting in a metamorphic rock. A quartzite in which all traces of the original grains and sedimentary structures are erased may also be called *metaquartzite*. A quartzite that preserves some sedimentary features is best described as a *metasandstone* or *metachert*.
The second way involves sandstone at low pressures and temperatures, where circulating fluids fill the spaces between sand grains with silica cement. This kind of quartzite, also called *orthoquartzite*, is considered a sedimentary rock, not a metamorphic rock, because the original mineral grains are still there and bedding planes and other sedimentary structures are still evident.
The traditional way to distinguish quartzite from sandstone is that quartzite fractures across or through the grains whereas sandstone splits between them.